Science Panel
August 25, 2010
Freshwater Sediment Standards
Overview of the Biological Freshwater Sediment Standards

Ecology's proposed Freshwater Sediment Standards are comprised of a narrative standard, numeric chemical criteria, and biological standards. These are developed using the same paradigm as the existing Washington State Sediment Management Standards (SMS) rule with two levels of effects. These are the lower 'no adverse effects level' corresponding to the Sediment Quality Standard (SQS) which serves as the goal for all sediment management activities in the state. The upper level is the 'minor adverse effects level' corresponding to the Cleanup Screening Level (CSL) which serves as the trigger above which contaminated sediments can be designated a cleanup site. The CSL also represents the upper bound of what may be left after active cleanup (the actual level is determined on a case-by-case based on a disproportionate cost analysis, taking into account net environmental benefits, technical feasibility and cost).

These biological standards provide a means to directly measure toxicity in freshwater sediments that may pose a significant adverse effect to established or potential benthic resources. They are intended to substitute for direct measurement of impacts to the benthic macro invertebrate community, recognizing the difficulty in establishing benthic community assessment methods that would be universally applicable to the highly variable freshwater sediment environments across the state. The use of sediment bioassays also has the benefit of assessing bioavailability of contaminants that is driven by numerous aspects of the environment (e.g., geological origin and sediment grain size, amount and nature of the sediment organic carbon, hardness and pH of porewater and overlying water, etc.). For these reasons, the SMS paradigm allows bioassay results to override the chemical criteria, since predicted toxicity based on chemistry alone is subject to many of the environmental variables that bioassays take into account.

Since bioassays serve as a surrogate for the sensitivity of a wide array of species that make up a benthic community, a suite of bioassays is conducted together, choosing from as many species and sensitive life-history stages as is practicable. At this time, the bioassays that have been most consistently used by laboratories performing work on regional sediments are limited to two species, the amphipod *Hyalella azteca* and the midge larvae *Chironomus dilutus*.

Reliable results using these two bioassays have been achieved looking at both acute and chronic exposure scenarios (exposure time relative to life history of the animal), measuring lethal and sub-lethal endpoints (see Table 1 below). The proposed suite would be selected from the bioassays presented in Table 1 and meet the following requirements:

Bioassay Suite to Include At Least:

- 2 Species
- 3 Endpoints
- 1 Chronic Test
- 1 Sub-lethal Endpoint

Test	Acute Bioassays	Chronic Bioassays	Lethal Endpoint	Sublethal Endpoint
Hyalella azteca				
10-day mortality *(ASTM E-1706 and EPA/600/R-99/064, Method 100.1)*	X		X	
28-day mortality *(EPA/600/R-99/064 Method 100.4)*		X	X	
28-day growth *(EPA/600/R-99/064 Method 100.4)*		X		X
Chironomus dilutus				
10-day mortality *(ASTM E-1706 and EPA/600/R-99/064, Method 100.2)*	X		X	
10-day growth *(ASTM E-1706 and EPA/600/R-99/064, Method 100.2)*	X			X
20-day mortality *(EPA/600/R-99/064 Method 100.5)*		X	X	
20-day growth *(EPA/600/R-99/064 Method 100.5)*		X		X
MicroTox				
100% Porewater *(Ecology, App. C, SAPA, 2008)*		X?		X

Table 1. Freshwater sediment bioassays proposed for adoption of biological standards. Acute and chronic tests and lethal and sub-lethal endpoints are indicated. Microtox is included in case it is desired to run this test in addition to a suite of three other endpoints (Microtox may not be substituted for one of the three endpoints required for regulatory interpretation).

Test Interpretation for the regulatory levels corresponding to the SQS (no adverse effects level) and the CSL (minor adverse effects level) is established comparing test sediment results to the negative sediment control. The interpretation of an endpoint requires two parts, demonstrating a statistically significant difference and a minimum reduction in growth or increase in mortality from control (see Table 2). The lower level SQS reflects the minimum detectable difference that is consistently attainable for each bioassay endpoint. The modest increase in effects at the CSL level represents the minor adverse effects level for each bioassay and endpoint.

Comparison to control rather than reference is a result of the difficulty in finding appropriate reference areas to match the variety of conditions present at freshwater sediment sites (e.g., physical, geological, hydrological and biological). This is typical for dealing with freshwater sediments and the regional sediment quality guidelines were developed comparing to control since reference sediments were not used in many of the studies or reference data was often of poor quality and failed Quality Assurance (QA) requirements. QA limits are included for control and reference performance, allowing for the use of a reference where an appropriate reference can be found.

Regulatory interpretation for an SQS level hit, using the biological tests, is when only one test endpoint from the suite of three exceeds the SQS level. A CSL level hit occurs when there are two or more SQS level hits or one or more CSL level hits.

Test	QA limits Control	QA limits Reference	SQS	CSL
Hyalella azteca				
10-day mortality	C ≤ 20%	R ≤ 25%	T – C > 15%	T – C > 25%
28-day mortality	C ≤ 20%	R ≤ 30%	T – C > 10%	T – C > 25%
28-day growth	CF ≥ 0.15 mg/	RF ≥ 0.15 mg/	T/C < 0.75	T/C < 0.6
Chironomus dilutus				
10-day mortality	C ≤ 30%	R ≤ 30%	T – C > 20%	T – C > 30%
10-day growth	CF ≥ 0.48 mg/	RF/CF ≥ 0.8	T/C < 0.8	T/C < 0.7
20-day mortality	C ≤ 32%	R ≤ 35%	T – C > 15%	T – C > 25%
20-day growth	CF ≥ 0.48 mg/	RF/CF ≥ 0.8	T/C < 0.75	T/C < 0.6
Microtox®				
15min decrease in luminescence	CF/CI ≥ 0.72	RF/CF ≥ 0.8	T/C < 0.85	T/C < 0.75

Table 2. Interpretation criteria for bioassay endpoints and QA limits for control and reference. Microtox is included in case it is desired to run this test in addition to a suite of three other endpoints (Microtox may not be substituted for one of the three endpoints required for regulatory interpretation). Reference performance limits are presented although interpretation criteria are based on comparison to control, there may be circumstances where an appropriate reference station can be identified. C=control, R=reference, T=test.